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Stephanopachys linearis (Kugelann, 1792) (Coleoptera, Bostrichidae) in Poland

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Abstract

Stephanopachys linearis (Kugelann, 1792) belongs to the family of horned powderpost beetles (Bostrichidae), represented in the fauna of Europe by 29 native species. It is a characteristic element of the northern, boreal zone of the Palaearctic and alpine areas of central and southern Europe. This species as a rare beetle important for the European Union, has been placed in Annex II of the Habitats Directive, on the IUCN Red List of Threatened Species and European Red List of Saproxylic Beetles. *S. linearis* was described from Poland in 1792 and, after 220 years, again encountered in this country. The zoogeographical distribution is shown and elements of its biology and ecology are discussed.

Keywords

Bostrichidae, *Stephanopachys linearis*, pyrophilous beetles, forest fire, *Pinus sylvestris*, Białowieża Forest, Poland

Introduction

Stephanopachys linearis (Kugelann, 1792) is a representative of the forest fauna characteristic of boreal and alpine regions of the Palaearctic. It belongs to the family of horned powderpost beetles (Bostrichidae), of which 29 native species occur in Europe

(Borowski 2007), 9 of them – including *S. linearis* – having been reported from Poland (Dominik 1958, Burakowski et al. 1986).

S. linearis was discovered and described in 1792 by the German entomologist J.G. Kugelann, working as an apothecary in Ostróda in the (then) Olsztyn regency of East Prussia (now NE Poland). Besides short Latin and German descriptions of *Apate linearis*, Kugelann gave a diagnosis allowing its distinction it from the now common bark beetle, *Anisandrus dispar* (Fabricius, 1792) (Curculionidae, Scolytinae), with information that the new species had been found only once, on an old hoarding. Kugelann's publication has become the basis of the inclusion – after World War II – of *S. linearis* in the Polish fauna (Dominik 1958, Burakowski et al. 1986, Borowski 2007), but during the 220 years since its description, it has never been reported from this country again and, for example, the renowned German faunist Adolf Horion (1961) considered its occurrence in Poland or Baltic countries as doubtful.

The current area of the distribution of *S. linearis* extends over the boreal zone of the Palaearctic, from Norway and Denmark, through Sweden, Finland and Siberia to the Far East (it was recently discovered in northern Manchuria – Zhang et al. 1995), reaching – through Estonia, Latvia and Lithuania – as far south as NE Poland, Belarus and Ukraine; relict localities are also spread over the mountainous regions of central and southern Europe (France, Switzerland, Germany, Austria, Italy, Slovenia and Bohemia – Borowski 2007), as well as the Caucasus (Horion 1961, Geis 2002) and on Corsica (Sainte-Claire Deville 1902). Its recent discovery in northern Iran (Liu et al. 2016, Nardi and Audisio 2016) seems highly doubtful: the locality, albeit close to the border of Azerbaijan, is practically devoid of vegetation, with the climate unsuitable for the development of this species, so the specimen seems either misidentified or mislabelled; one of us (JB) contacted the Iranian author of the respective publication for possible verification of its taxonomic identity, but the specimen proved unavailable not only for loan but even for taking a photograph.

In the years 2009–2017, in the course of the study of saproxylic insects on a burned site in Białowieża Primaeval Forest, the existence of this species has been discovered. Information concerning this discovery and the data supplementing the current knowledge on the ecology of the development of *S. linearis* are provided below.

Materials and methods

Locality and collection data

In 2009, the research programme was launched in Białowieża Primaeval Forest (Faliński 1986) to study the dynamics of the changes in species composition and abundance of (especially saproxylic) beetles after the disturbance caused by the forest brushwood fire on 28.04.2009. The studied area of the burned site (ca. 7 ha), in the compartment 105B of the Białowieża National Park, included natural stands with high proportion of

old (120 years or more) trees in humid forest (60.5% of the disturbed area), boggy forest (24.5%) and humid mixed forest (13.2%). The site has been left without economic activity, with actions having been restricted to scientific research. The observations started a few days after the fire. Beetles were caught in 2009–2011 and 2015–2017 using 9 non-baited Moericke's and 18 Netocia-type traps (Piętka and Borowski 2015) as well as 3 black funnel traps each baited with α-pinen, ethanol, fuscumol, ipsenol and ketol (https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/spruce-beetle-docs/spruce_beetle_funnel__traps.pdf). All traps were suspended 1-2 metres above ground.

In June 2017, we measured the diameter at breast height and extent of trunk scorching (from the ground level) of 140 living pine-trees in the burned area and evaluated (in a three-level scale: slight, medium, strong) the degree of insolation of each trunk. All trees had been carefully examined for the presence of *S. linearis* larval galleries.

Statistical methods

To assess the preferences of *Stephanopachys linearis* for particular types of trees, we used a Generalised Linear Model (GLM), with binomial distribution for response variable (0 = tree not occupied by beetle, 1 = tree occupied by beetle). In the model, we used three explanatory variables: diameter of a tree degree of burning of the trunk (continuous, log-transformed variables) and exposure to the sun (categorical, three-level variable). All analyses were done using R (version 3.2.2) software.

Results

The first specimen of *Stephanopachys linearis* (Fig. 1) was caught between 26.04.2015 and 11.05.2015 in the Netocia-type trap on living but scorched pine; it was identified in autumn 2016 and we decided to look for the species at the same place in 2017.

On 9.05.2017, we searched for the species on living insolated pines with visible scorching of the outer layer of bark (Fig. 2). The trees did not show any signs of weakness and, had well developed crowns with green needles. On the black, scorched surface of bark, we saw small (1.4–2.0 mm in diameter) rounded exit holes of *S. linearis* from the previous year (Fig. 3). Whittling the outer bark layer away exposed galleries in the inner layer or under the bark (Fig. 4). Tortuous, variously directed, frequently inter-crossing or overlapping galleries 1.0–2.2 mm in width, filled with fine brown sawdust, did not enter the xylem. Humidity in the feeding places was moderate with a tendency to low. In the galleries, one dead individual, remnants of five others and a living larva of *S. linearis* were found. Galleries occurred only in the scorched part of the trunk, at a height of 0.3 to 2 m, all around the tree.

Figure 1. *Stephanopachys linearis*; the specimen collected in Białowieża Primaeval Forest in 2015 – dorsal view (photo by M. Sławski, 2017). Scale bar = 1 mm.

Also in 2017, black, baited funnel traps were suspended near the place where *S. linearis* had been previously collected and, in one of them one more specimen (22.05.–5.06.2017) and remnants of another one (20.06.–3.07.2017) were found.

Figure 2. Scots pines burned by fire – host trees of *Stephanopachys linearis* (photo by J.M. Gutowski, 2017).

Figure 3. Imago outlets of *Stephanopachys linearis* (photo by J. Borowski, 2017).

Figure 4. Larval galleries of *Stephanopachys linearis* in the Scots pine bark (photo by J. Borowski, 2017).

Tree preferences

Amongst the measured and analysed trees, 16, i.e. 11.5%, were infested. Logistic regression analysis showed that the beetles preferred trees significantly thinner (mean diameter at breast height: 28 cm) than the average (32 cm; GLM, $z = -2.303$, $p = 0.021$) and more strongly scorched (mean height of scorching 245 cm for infested trees vs. 195 cm for all trees, GLM, $z = 3.050$, $p = 0.002$), while insolation of trunks was irrelevant (GLM, $z = 0.272$, $p = 0.786$) (Fig. 5).

Thus, it seems that *Stephanopachys linearis* prefers thinner trees (it has not been found on the thickest ones), most frequently those of 15-34 cm diameter at breast height (14 trees) and only once it was found feeding on a pine of 38 cm diameter. On the basis of our observations, this species feeds only on living trees, on small subcortical surfaces, where fire had locally damaged the cambium and phloem; it heavily infests scorched pines (up to the height of 135–350 cm), avoiding those blackened only below 130 cm.

S. linearis was accompanied by the deadwatch beetle *Ernobius mollis mollis* (Linnaeus, 1758) (Ptinidae, Ernobiinae); their galleries were almost identical, but the anobiid prefers those places where the fire had killed the cambium, its larvae feed deeper, frequently damaging the cambium and outer layer of xylem. Its exit holes are somewhat larger and less regular.

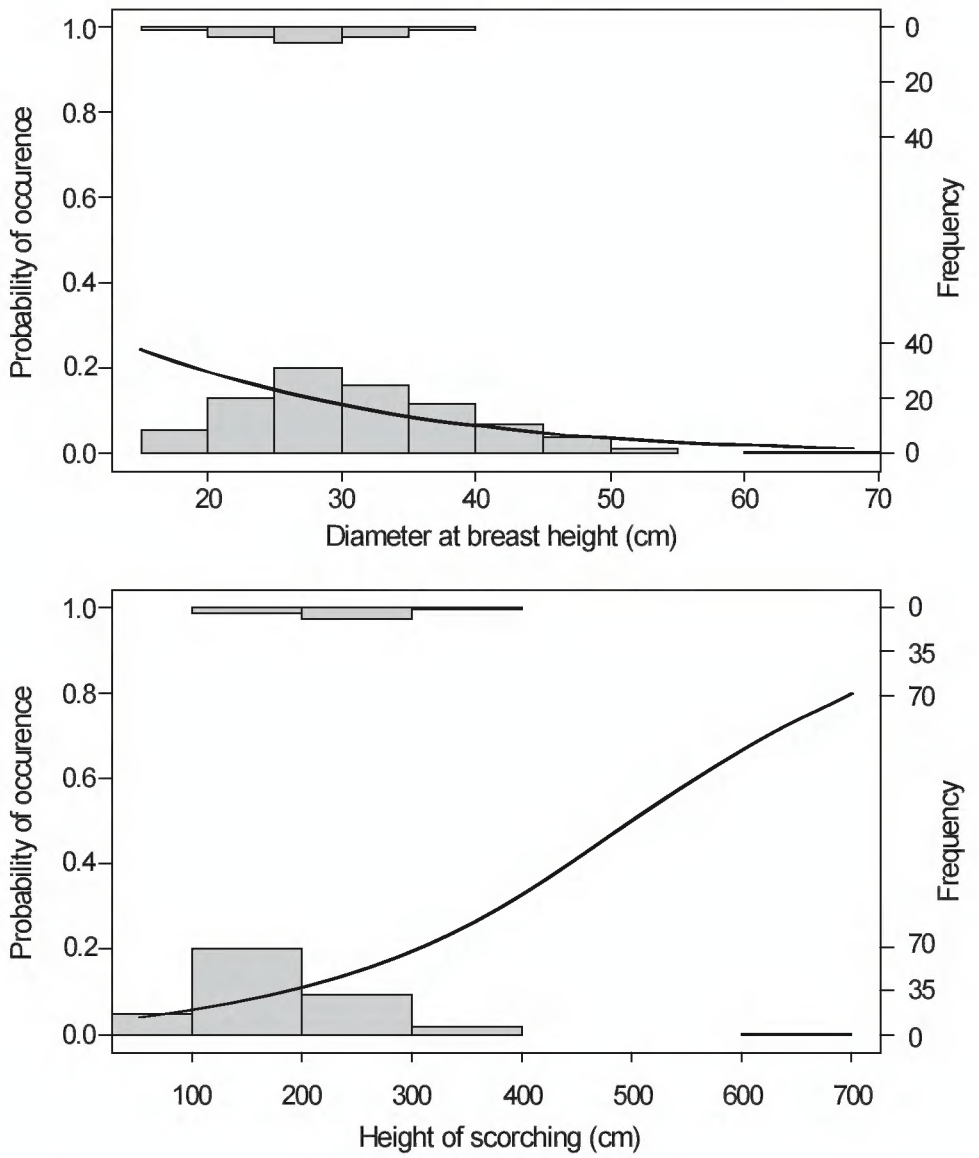

Figure 5. Result of logistic regression in the study of significance between the trees colonised by *Stephanopachys linearis* and the size of breast height and the height of the trunks' blackened by fire.

Discussion

Bionomy of *Stephanopachys linearis*

Stephanopachys linearis is bound biologically to conifers: in the northern zone mainly with Scotch pine (*Pinus sylvestris* L.), in the alpine areas on various species of pines, larches, much less frequently spruces and firs (Brustel et al. 2013, Ranius et al. 2014, Nardi and Audisio 2016). As a pyrophilous species, it primarily infests living trees damaged by fire, being only rarely found on those showing mechanical wounds like bark flayings or local necrosis. Before intensive forest management, the species probably proliferated on areas of natural fires and, when fire did not occur, on lightning-damaged trees. Like the majority of bostrichids, swarming in Poland occurs in spring, from late April to June. As a representative of the subfamily Dinoderinae, females probably gnaw into the bark to lay eggs. Larval galleries, filled with brown cortical sawdust mixed with faeces, terminate with ovate pupal chambers, from which imagines gnaw their round exit holes through bark. The beetles may develop on the infested tree during at least several years (Wikars 2006).

The galleries of *S. linearis* run at the contact surface between bark and phloem, but larvae feed only in bark, not in living phloem, selecting the layer of dead dry phloem previously killed by fire and then overgrown with new, living tissue. The species prefers the unusual environment produced by, for example, fire. As thick bark protects phloem from being killed by fire, the beetles infest mainly thin-barked trees where the subcortical tissues could have been more easily "boiled". Infestation occurs only after partial regeneration of phloem has occurred, usually 2–5 years after the fire (Wikars 2006).

Status of *Stephanopachys linearis* in Europe

Stephanopachys linearis is the 20^{-th} – first of the family Bostrichidae (Gutowski and Przewoźny 2013) – of the beetle species listed in Annexes I and II of the Habitats Directive (Council Directive 92/43/EEC), which have been found in Poland. As a rare species, important for the European Union, it has been placed in Annex II of the Habitats Directive (code: 1926) (Gutowski and Przewoźny 2013; Council Directive 97/62/EC), as well as in the *IUCN Red List* and *European red list of saproxylic beetles* (Nieto and Alexander 2010) – in both cases with the category LC – and *Red list of near-extinct and threatened animals in Poland* (Pawłowski et al. 2002) as probably extinct (EX?). *S. linearis* could probably be considered at the Polish regional scale as "Critically Endangered (CR)" following the IUCN criteria B1ab (i,ii,iv) (IUCN 2014).

Apart from *S. linearis*, considered as an obligatory pyrophile, many other beetle species are associated with burned areas, which – as important causes of natural ecological disturbances – make a significant element of the strategy for preservation of biodiversity (Wikars 1992). In the past, ground fires were frequent in the Białowieża Primaeval Forest (Niklasson et al. 2010, Zin et al. 2015), as in Scandinavia (e.g. on the Swedish island Gotska Sandön – Niklasson 2015). The occurrence of many rare pyrophilous beetles (Gutowski and Jaroszewicz 2001, Gutowski et al. 2012, Niklasson 2015) in these areas is probably a consequence of that "igneous" past.

Concluding remarks

Unfortunately, despite its being listed in the EU Habitats Directive, *S. linearis* remains poorly known with regards to its biology of development, and many data from various reports placed from time to time in the internet are contradictory, making them difficult to interpret reliably.

The confirmation of the occurrence of *S. linearis* in Poland will probably stimulate more focused attention to the trees – especially pines – damaged by fire. The authors are convinced that the species can also be found elsewhere in the northeastern parts of Poland, perhaps on larger surfaces with more numerous infested trees (in Białowieża the relevant area was relatively small: 7 ha, 16 pines with galleries of *S. linearis*). This would allow more detailed studies hopefully resulting in the clarification of its bionomy, at the level of other, well recognised species listed on the EU Habitats Directive.

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